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CLEAN ROOM TRANSPORTATION PACKAGE FOR PROCESS CHAMBER KIT

Inventor:

Ronald Vern Schauer,
A citizen of the United States of America,
9480 Sugar Babe Drive,
Gilroy, CA 95020.

Assignee:	Applied Materials, Inc.
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CLEAN ROOM TRANSPORTATION PACKAGE FOR PROCESS CHAMBER KIT

BACKGROUND

An aspect of the present invention relates to portable package to transport a process chamber kit having different components into a clean room.

Many different types of packaging are used to transport process chamber components into a clean room environment, which is a room in which the ambient particle content in the environment is under control to allow contamination free processing of integrated circuit chips and displays. In one type of packaging, individual chamber components are surrounded by sealed plastic bags, which nest inside cut-outs of a foam block matrix. The foam block matrix is secured in a component box and shipped to a distribution site or a customer, in shipping containers. Cleanroom foam is a highly compressed, spongy, polyethylene foam material, such as for example, Zotefoam's "Plastazote LD-24", from FP Technologies, Ventura, California. The foam block matrix comprises individual blocks of cleanroom foam that are bonded to one another to form the requisite cut-out shapes. The component boxes typically have sidewalls of plastic or other materials that are joined with metal edging and filled with a block matrix of foam. The component boxes have handles to facilitate transportation of the packed components to the cleanroom environment.

Conventional packaging has a number of problems associated with the transportation and opening of such packaging in the cleanroom environment. For example, conventional packaging often generates contaminants and undesirable outgassing in the cleanroom environment. Typically, the shipping container is unpacked outside the cleanroom, and the inner component box is removed. When cleanroom foam is used, the foam block matrix is often unpacked in the cleanroom environment. However during such unpacking and removal of the component parts from the foam block, the individual grains or small chunks of the foam can abrade off and create contaminant particles. Furthermore, cleanroom foam typically has an open cellular structure that is porous, for example, with pores sized about 10 to 100 microns. The gases trapped in these pores can outgas into the cleanroom environment. The bonding layers between the separate blocks of foam that are used to create the three-

dimensional block matrix can also outgas or create polymeric contaminant particles.

In some cases, the foam materials of the block itself cannot be brought into the cleanroom, so the individual sealed component bags have to be unpacked and carried into the cleanroom. During such transportation, the soft plastic that is used to form the sealable package around individual component parts can rupture causing the internal parts to become contaminated by the external environment. Storage of the soft plastic bags in the cleanroom environment for eventual use is also difficult because they are not easily stackable and can be punctured. Moreover, the mere act of carrying the individual component parts for some distance raises the risk of dropping and damaging the parts.

A further problem arises because the foam materials and external box do not allow visual examination of their internal contents. For example, if a chamber component breaks or chips within the closed box, the breakage is often not discovered until the box is opened in the cleanroom environment. Moreover, in an intermediary transportation point, such as a parts distribution warehouse, the state of the packaged components cannot be inspected prior to shipment to the consumer without opening the container and contaminating the component part. In addition, stringent customs inspections involved in international transportation that require the opening of such containers to allow the customs agent to verify the internal contents, necessitates breaking the seal in a potentially adverse environment, and may cause the part to be subsequently scrapped upon completing the voyage.

Yet another problem arises because it is difficult to attach labels onto conventional foam packaging. Typically, a recessed area is machined into the foam container by routing, and a thick epoxy layer is applied within the recess. The label is then adhered to the thick epoxy layer. However, such epoxy materials can outgas in a low pressure environment or when heated to even ambient room temperatures. In addition, in the routing process the foam can fragment, thus generating defective packaging.

Another problem arises when transporting or shipping a process chamber kit having a number of different chamber components that are related to one another. For example, the kit may comprise different portions of a liner to line the walls of the

process chamber. These liners are routinely cleaned, refurbished, or replaced during operation of the chamber, so it is often necessary to ship a kit of related liner parts at the same time. When such kits are separately packed and shipped, it becomes necessary to reassemble the kit at a distribution center or customer site, wasting resources and sometimes resulting in an improper assembly of parts. This problem is further exacerbated when unpacking conventional packaging and transporting the individual components of a kit into the clean room, where they are promptly misplaced or intermingled with other components, especially if they are stored for some time before use. Storage in the clean room is desirable to reduce chamber downtime, by allowing prompt replacement of a component part when it fails or needs cleaning. Unsealed or loose part kits can also be lost or stolen.

Thus, it is desirable to have a packaging that allows a sensitive chamber component part to be safely transported from the fabricator to a cleanroom environment. It is also desirable for the packaging to maintain a gas tight seal from the external environment. It is further desirable that the packaging can be easily labeled. It would also be desirable to have packaging that allows visual inspection of internal parts without breaking seals or opening the packaging. It is also desirable to transport and store a kit of related parts and identify them as needed. Moreover it is desirable that the packaging be capable of being fitted with anti-tamper tapes, seals, locks, or other means.

SUMMARY

A clean room transportation package is useful to transport a process chamber kit having a plurality of differently shaped chamber components directly into a clean room environment. The package comprises a first rigid tray having a first ledge with a first rim and a plurality of first troughs extending outwardly from the first ledge. A second rigid tray is detachable from the first tray. The second tray has a second ledge having a second rim that couples with the first rim of the first ledge to form a seal therebetween. The second tray also has a plurality of second troughs extending outwardly from the second ledge. A plurality of conformal cells having different internal surface profiles are formed by facing pairs of first and second troughs when the two trays are assembled together. The internal surface profile of each conformal cell matches an external surface profile of a chamber component so that movement of the chamber component in its conformal cell is minimized during transportation. At least a portion of the first or second tray is substantially transparent so that a state of each chamber component of the process chamber kit may be observed through the substantially transparent portion.

DRAWINGS

These and other features, aspects, and advantages of the present invention will be better understood from the following drawings, description and appended claims, which are provided to illustrate exemplary features of the invention and should not be used to limit the invention, where:

Figure 1 is an exploded perspective view of a transportation package showing facing first and second trays having troughs that define a set of conformal cells for holding a process chamber kit having different chamber components;

Figure 2 is an exploded perspective view of a tray having a sidewall comprising removable panels;

Figure 3a is a exploded cross-sectional schematic view of a transportation package comprising a pair of matching trays that define conformal cells which each have an internal surface profile that conforms to an external surface profile of a particular chamber component of a process chamber kit;

Figure 3b shows the transportation package of Figure 3a, after assembly of the trays around the chamber components, evacuation of the air inside through a valve outlet, and input of clean and dry air or inert gas through a valve inlet;

Figure 4 is cross-sectional schematic view of a trough having a trough wall with facing resilient dimples, which when compressed, exert an inward force that holds a chamber component in place; and

Figure 5 is cross-sectional schematic view of stacked transportation packages showing the stacking tabs and corresponding recesses that fit one another.

DESCRIPTION

A portable transportation package **20** is useful to transport and store a process chamber kit **22,** which has a number of different chamber components **24a-f**. The package **20** allows the chamber components **24a-f** to be transported directly into a clean room environment without exposure to the environment and without breaking seals. The chamber components **24a-f** are parts that are portions of the process chambers, platforms, and gas supplies, which are used in the fabrication of integrated circuits, such as semiconductor wafers, and flat panel displays. The chamber components **24a-f** are sensitive to contamination by dust particles, and may sometimes be easily damaged when exposed to the external ambient environment, such as by oxidation from air or corrosion by water vapor.

Generally, the package **20** comprises a pair of first and second trays **50, 60**, which when assembled together, oppose and face each other as shown in Figure 3b and Figure 5. The package **20** illustrated herein is only an exemplary embodiment according to the present invention, and should not be used to limit the scope of the invention. The trays **50, 60** are made from a material that is sufficiently rigid to withstand external shocks during transportation, and have a smooth, resilient, and non-granular surface that, unlike foam packaging, does not release individual grains when abraded against the surfaces of the chamber components **24a-f**. Preferably, the surface of the trays **50, 60** is continuous, unbroken and non-porous and is absent individual grains that can flake off when receiving a chamber component **24a-f**, or in the unpacking of a chamber component **24a-f** placed in the trays **50, 60**. In one version, for example, the smooth and resilient surface of the trays **50, 60** can have an rms roughness of less than about 10 microinches. The assembled pair of trays **50, 60** serve as a self-standing receptacle to receive a process chamber kit **22** of chamber components **24a-f** and can even have built-in handles to transport the chamber components **24a-f** directly into a clean room. The assembled pair of trays **50, 60** can also be stored for a period of time in the clean room in a sealed and stable environment, and disassembled only when the chamber components **24a-f** are needed for immediate use in a process chamber, thereby further reducing any contamination of the chamber components **24a-f** in the trays **50, 60**.

Generally, the first tray **50** comprises a first ledge **52** having a first rim **54** that can be coupled to a corresponding second rim **64** of a second ledge **62** of the second tray **60**. The ledges **52, 62** can be planar or angled strips of rigid material that are parallel to one another. The ledges **52, 62** can also be shaped as a frame having a circular, square or rectangular form. The rims **54, 64** are planar and substantially parallel to one another and are integrally formed around the periphery of the trays **50, 60**. Each rim **54, 64** has a sufficient width to allow the rims **54, 64** to be joined to one another to form a surface seal. Generally, the rims **54, 64** are smooth and continuous, however, they can also have sealing projections extending therefrom, as described below. Other versions of the rims **54, 64** can also be used, for example, the rims **54, 64** can be slanted or sloped at matching acute and obtuse angles, relative to a central axis or central plane of the chamber components **24a-f** carried in the trays **50, 60**.

In the first tray **50**, a plurality of first troughs **56a-f** extends outwardly and downwardly from the first ledge **52**, as shown in Figure 2. In this version, the first ledge **52** is a rectangular open frame that extends around, or can even surround, the first troughs **56a-f**. The first troughs **56a-f** are each shaped and sized to have an internal volume that is shaped and sized to conformally accommodate a portion of a process chamber component **24a-f**. When the different troughs **56a-f** are shaped and sized to accommodate different process chamber components **24a-f**, the depressions are longitudinally separated with separator sections **120a-b**. For example, a trough **56a** can be shaped to have a single depression conforming to the external profile of a portion of a process chamber component **24a** received in the trough **56a**. The troughs **56a-f** can also be shaped to have a plurality of depressions, such as concavities having different radiuses or widths, which are integrated to continuously flow into one another to accommodate different annular diameters of the chamber components **24a-f**.

Similarly, the second tray **60** also has second troughs **66a-f** that extend outwardly from the second ledge **64**. When the two trays **50, 60** are assembled, as shown in Figure 3b and Figure 5, a particular second trough **66a** opposingly faces a particular first trough **56a** to define a unique cell **92a** having an internal surface profile **93a** that conforms to an external surface profile **94a** of a particular chamber component **24a**. Thus, each unique conformal cell **92a-f** has an internal volumetric contour that is shaped to hold a predefined chamber component **24a-f** securely to minimize lateral or vertical movement of the chamber components **24a-f** in the cells **92a-f** during

transportation, since the contour of the cells **92a-f** is closely matched to the contours of the chamber components **24a-f**. In this manner, a plurality of conformal cells **92a-f** having different internal surface profiles **93a-f** are formed by the facing pairs of first and second troughs **56a-f, 66a-f**. The internal surface profile **93a-f** of each conformal cell **92a-f** closely matches an external surface profile **94a-f** of a chamber component **24a-f**. For example, the internal surface profile **93a** of a particular cell **92a** can be shaped to closely follow the contour of the external surface profile **94a** of a chamber component **24a** with a gap of about 5 to about 30 mms between the two surfaces **93a, 94a**. However, other gap sizes are also possible, the size of the gap depending on how tightly it is desirable to hold the particular chamber component **24a** in the cell **92a**.

For example, the pairs of first and second troughs **56a-f, 66a-f** can be shaped, sized, and spaced apart to accommodate a set of chamber components **24a-f** that make up a kit **22** of related parts of a process chamber which have a common function or common assembly purpose. For example, the troughs **56a-f, 66a-f** may be constructed to hold different chamber components **24a-f** that are all part of a process chamber kit assembly **22**. One type of process chamber kit **22** contains, for example, different segmented portions of a wall liner to cover up part of an internal chamber wall or different portions of a gas distributor. Another example of a kit **22** is an assembly of concentric rings that are placed around a substrate in a process chamber, such as a shadow ring, outer ring, and pumping plate. Yet another kit **22** may include a focus ring, a chamber sidewall liner, and a substrate clamping ring. Each chamber component **24a-f** of the kit **22** fits into a matching conformal cell **92a-f** formed by a pair of first and second troughs **56a-f, 66a-f**.

The individual cells **92a-f** formed by pairs of matching first and second troughs **56a-f, 66a-f** can be separated by the separator sections **120a-e** which are sized to maintain a sufficient gap between adjacent cells that the chamber components **24a-f** in each cell **92a-f** do not contact one another during transportation. The separator sections **120a-e** can be shaped and sized so that when the trays **50, 60** are coupled, the cells **92a-f** are isolated from each other. However, to facilitate gas evacuation and purging from the cells **92a-f**, the separator sections **120a-e** can also be shaped and sized to allow gas fluid communication between the cells **92a-f** so that the air in the cells **92a-f** can be evacuated from a single output that accesses the entire cell assembly, and similarly replaced from a single input. A suitable gap size depends on

the size of adjacent chamber components **24a-f**, and for example, can be from about 5 mm to about 40 mm. However, other gap sizes can also used, depending on how tightly it is desired to hold a chamber component **24a-f** in a cell **92a-f**.

In one version, the second troughs **66a-f** of the second tray **60** have substantially the same shape as the first troughs **56a-f** of the first tray **50**, and they are juxtaposed in mirror relationship to the first troughs **56a-f**, when the two trays **50, 60** are joined together. Because they have substantially the same shape, both trays **50, 60** of this version can be more economically fabricated using a single mold having the same cross-sectional profile as described below. Also, this version is particularly useful to carry chamber components **24a-f** that have a radial symmetry, such as cylindrical or axially symmetric chamber components **24a-f**. By substantially the same shape it is meant the same cross-sectional profile, however, one of the profiles may have additional features, such as a protruding knob or other feature, that is used for other purposes.

In yet another version, one or more of the first and second troughs **56a-f, 66a-f**, have trough walls **178a-b** that are shaped to exert an inward mechanical bias force to hold a chamber component **24b** at a single or multiple contact points when the chamber component **24b** is placed inside the trough **56b**. Trough walls **178a-b** can have an inwardly extending dimple **180**, as shown in Figure 4, that is compressed when a chamber component **24b** is placed inside the trough **56b**. As a result, the dimple **180** exert a springy inwardly biased force at the contact point with the chamber component **24b** that holds the chamber component **24b** firmly inside the trough **56b** with the minimum surface are in direct contact with the chamber component **24b.** The facing trough walls **178a-b** can also have opposing dimples **180a-b** to exert counter forces on the chamber component **24b** placed in the trough **56b**. Other methods of exerting such an inward force may also be used, for example, compliant ring structures, metal springs, spring clamps (none shown) that are mounted on the exterior surface of the trough **56b** so as to compress it slightly, and pads of cleanroom-compatible compliant material applied to the interior of the trough **56b** at appropriate points. Such a version is advantageous to hold chamber components **24a-f**, or a surface of a chamber component **24a-f** that is friable or easily damaged when abraded against the internal surface of the trough walls **178a-b** during transportation.

In one version, rigid sidewalls **96a-d** are provided to support at least one of the first or second trays **50, 60**. The sidewalls **96a-d** extend around the tray **50, 60** and have a height that is sufficiently large to extend beyond the depth of any of the troughs **56a-f, 66a-f**. The sidewalls **96a-d** are also constructed to have a vertical or slanted profile that maintains rigidity during transportation. In one version, the sidewalls **96a-d** comprise a substantially planar wall that is perpendicular to the plane of the ledge **52, 62**. The planar wall has a surrounding circumferential lip extending inwardly along all four sides of the wall to improve the shearing strength of the sidewall structure. Alternative rigidity enhancing structures, such as cross beams or a pattern of hexagonal units, can also be used to enhance the strength of the sidewalls **96a-d**. The sidewalls **96a-d** can also be fabricated from a composite material, such as an epoxy resin with other embedded materials to improve structural rigidity.

In one version, the sidewalls **96a-d** comprise a set of removable panels **100a-d**. Each removable panel **100a-d** can have substantially the same shape, so that the panels **100a-d** can be fabricated from a single mold. A suitable set of four panels **100a-d** having the same shape is illustrated in Figure 2. Each panel **100a-d** comprises a right-angled lip **101a-d** that is recessed from the main sidewall surface of the panel **100a-d**, and that fits into a corresponding matching slot **102a-d** below the perimeter of a tray **50**. A ledge **52** of the tray **50** with outwardly extending troughs **56** is placed over four adjacent sidewall panels **100a-d** so that each lip **101a-d** of the sidewall panels **100a-d** fits into a corresponding slot **102a-d** in the lower surface of the ledge **52**. A set of screws **103a-l** and joining clamps **105a-h** can be used to join the panels **100a-d** to the ledge **52** or to each other.

The rim portions **54, 64** of the first and second trays **50, 60** can be coupled together to form a gas tight seal **107** between the trays. The gas tight seal **107** between the two trays **50, 60** allows contamination free transportation of the chamber components **24a-f** therein. For example, in one version, the rim **54, 64** of one or more of the trays **50, 60** has a groove **108a-b** that can accept a gasket **112a-b**, such as an O-ring or other soft polymer seal, as shown in Figure 3b. A latch **82a-d** attached to the first tray **50** and a latch tab **84a-d** attached to the second tray **60** allows the two trays **50, 60** to be sealed at the gasket **112a-b** between the trays **50, 60** to maintain a gas tight seal **107** therebetween, as shown in Figure 3b and Figure 5. The latch **82a-d** can be a conventional latch such as a plastic strip having a corrugated flexible hinge portion

122a-d attached to a panel **100a-d** of the first tray **50** and having a claw portion **123a-d** extending out from the hinge portion **122a-d**. In use the claw portion **123a-d** is hinged out and forced over the end of a latch tab **84a-d** that is attached to the panels **100a-d** of the second tray **60**. In another version, a series of raised U-shaped bulbuous posts in the rim **64** of the second tray **60** couple to corresponding bell-shaped indentations in rim **54** of the first tray **50** to form a seal therebetween (not shown). In yet another version, the second rim **64** has a circumferential lip that snap fits into a corresponding slot in the first rim **54** to form the seal (also not shown), and after the trays **50, 60** are engaged, they can be released from engagement by pulling apart the two rims **54, 64**.

The gas tight sealed version of the package **20** can also include a first valve **140** to evacuate the sealed set of conformal cells **92**, and a second valve **144** to introduce a gas into the evacuated cells **92**. For example, the first and second valves **140, 144** can be Schrader valves, which allow the introduction or evacuation of gas when a spring-loaded pin **148** in the center of the valves **140, 144** is displaced. The first valve **140** may be connected to a pump **156** that evacuates the sealed cells, and the second valve **144** may be connected to a gas supply **160** that introduces clean dry air (CDA) or inert gas into the sealed cells. Alternatively, a single valve may also be used for both evacuation and gas purging or filling functions (not shown).

The opposing portions of the sidewalls **96a-d**, or the removable panels **100a-d**, can also have one or more pairs of built-in handle cut-outs **98a-d** that face each other. The handle cut-outs **98a-d** allow an operator to lift and easily transport the package **20** to the cleanroom environment. Such handle cut-outs **98a-d** are advantageous because they do not extend out of the assembled package **20**, and consequently occupy less cleanroom storage space. The handle cut-outs **98a-d** are also more resistant to breakage during transportation. The handle cut-outs **98a-d** can also be easily fabricated into the sidewalls **96a-d** or removable panels **100a-d** without joining additional parts to the trays **50, 60**. However, external handles may also be affixed onto the sidewalls **96a-d** or removable panels **100a-d**, or the other surfaces of the trays **50, 60** (not shown).

In use, one of the trays **50, 60** is selected as a lower or base tray, for example, the first tray **50,** and is placed on a work surface. Each chamber component **24a-f** is inserted upright into one of the open troughs **56a-f** of the lower tray **50**. After

filling the tray **50,** the other tray **60** is used as the upper or cover tray and fitted over the portions of the chamber components **24a-f** that extend out of the troughs **56a-f** of the lower tray **50**. The latches **82a-d** are then engaged to the latch tabs **84a-d** to lock the upper tray **60** onto the lower tray **50**. Each chamber component **24a-f** is now captured within a cell **92a-f** that is tailored to conformally fit a particular chamber component **24a-f,** and is isolated from the other chamber components **24a-f**. Moreover, because the chamber components **24a-f** are all contained in a single package **20**, it is easier for a distributor or customer to locate the entire kit of parts. Furthermore, when the rigid trays **50, 60** are at least partially made of a substantially transparent polymer material, it is easier to identify the chamber components **24a-f** within the package **20**, as those corresponding to a particular kit **22**.

The rigid trays **50, 60** can be fabricated from a number of different materials that provide the desired rigidity for transportation, i.e., the material is sufficiently rigid to absorb shock without fracturing when it is formed into trays **50, 60** and chamber components **24a-f** are placed in the trays **50, 60**. The rigid material of the trays **50, 60** should have a tensile modulus of elasticity of at least about 1800 Mpa when measured under ISO 527, for example, at a rate of 1 mm/min.

Preferably, at least a portion of the trays **50, 60**, or the entire trays **50, 60** are made from a rigid material that is also substantially transparent to allow visual examination of the chamber components **24a-f** held inside the trays **50, 60**. Substantially transparent means it is translucent or transparent to visible light. For example, a suitably transparent material can have a visible light transmission percentage of at least about 80%. The first or second troughs **56a-f, 66a-f** of the assembled trays **50, 60** can also be surface polished to enhance the clarity of transmitted light and views. The transparent portions allow a clean room operator to visually detect or examine the contents of the trays **50-60** without breaking open the seals. For example, in one version, only one or more of the first or second troughs **56a-f, 66a-f** are made from the substantially transparent material, however, the entire of both trays **50, 60** can also be made from the substantially transparent material.

The substantially transparent portions also allow identification labels, or component bar codes, to be stuck on the inside of the trays and still be visible from the outside. This prevents damage to the label during transportation or storage. Also, the

rigid surface of the trays allows conventional labels to be easily stuck on the trays, without machining recesses or special epoxy glues, as required in clean room foam products.

A suitable substantially transparent rigid material is a heat setting thermoplastic polymer, such as a high density polyethylene, for example polymers that are based on polyethylene terephthalate (PET), glycol-modified PET (PETG), oriented PET (O-PET), or polyethylene naphthalate (PEN), or blends thereof with each other or with other resins. Preferably, the transparent rigid material is a moldable thermoplastic that softens when heated to form to a mold shape, such as polyethylene terephthalate Glycol (PETG), such as PAL_G sheet fabricated by Palram, Ramat Yohanan, Israel. The rigid trays **50, 60** can be molded as a single integral piece using conventional plastic molding techniques from a single blank sheet of thermoplastic material. The blank sheet can be thermoformed into heat-set, thin walled trays utilizing conventional thermoforming methods and equipment such as vacuum assist, air assist, mechanical plug assist or matched mold.

In one method of fabricating the trays **50, 60**, a thermoplastic sheet is placed over a male or female mold of the tray and heated until it softens into the mold. The preheated thermoplastic sheet is drawn into the mold, which may also be heated, by the application of pressure using an opposing matched mold shape or by evacuating the sheet from below the mold. For example, if the sheet is heated and allowed to soften into a female mold, a male mold can be used to apply a conformal opposing pressure on the other side of the heated sheet, and the male mold can be gradually cooled to room temperatures serving as a secondary cooling mold. The thermoplastic sheet is heat-set by maintaining contact against the heated mold surfaces for a sufficient time period to fully conform to the mold profile, gradually cooling the formed sheet to room temperatures, and then removing the tray preform out of the mold cavity. A vacuum may also be applied through the mold(s) to draw out any trapped air. The tray preform can then be trimmed or otherwise formed to add handle cut-outs **98a-d** and other projections and shapes to form a locking tab and other features. The sheet must be heated above its T_g (glass transition temperature) and below the point at which it sags excessively during positioning over the mold cavity. In the thermoforming process, a sheet temperature within the range of about 120° C to about 240° C is suitable. The mold can be made from wood, resins, or a metal such as aluminum, or

even steel. For fabricating small quantities of trays **50, 60**, soft materials such as wood can be used.

Instead of a single ply sheet, a multi-ply sheet can also be used. The multi-ply sheet can also include a first ply composed of a thermoplastic polymer, such as PETG and a second ply composed of a composite material, such as a fiberglass epoxy sheet. Also, the trays **50, 60** can be fabricated such that a portion, for example, of the troughs **56, 66** is fabricated from the substantially transparent material, whereas, other portions such as the sidewalls **96a-d** or removable panels **100a-d** are fabricated from a more rigid or stronger material, such as a sheet of fiberglass strands embedded in epoxy resin.

In an alternative embodiment, the trays **50, 60** or a portion of the trays **50, 60** is fabricated from metal, such as aluminum or steel. However, this embodiment does not allow see through of the state of the chamber components **24a-f** post shipping, or the inspection of labels placed inside the trays **50, 60**. Thus, the trays **50, 60** could be fabricated to have both non-transparent portions, such as a non-transparent ledge **52, 62** that is joined to a substantially transparent trough **56a-f, 66a-f**, so that the chamber components **24a-f** inside the troughs **56a-f, 66a-f** are still visible through the transparent walls of the troughs **56a-f, 66a-f**.

In yet another embodiment, a portion of the trays **50, 60** is colored according to a color selected from a color code table that lists different colors and corresponding kit **22** or part numbers of the chamber component **24a-f**. For example, the substantially transparent portion of the trays **50, 60** may be colored, or another portion of the trays **50, 60** such as an opaque portion may be colored. The colors can include any visible wavelength from the color spectrum and include white or black. The color code table lists individual colors associated with a corresponding process chamber kit **22**, chamber component **24a-f**, or process application. For example, the table can list the color blue associated with aluminum etching chamber process kits and yellow or orange for copper chamber kits. Such color-coding allows a clean room operator to easily distinguish and properly identify the spare parts used for a particular chamber or application. As a result, the seal of the package **20** does not have to be broken to inspect the chamber components **24a-f** to determine their function, and the integrity of the chamber components **24a-f** can be preserved for a longer time.

The list of the color code table can also associate different colors for process chamber kits **22** that have identical chamber components **24a-f** but which have been used in different process applications, which, for example, are mutually incompatible. For example, both aluminum and copper interconnect fabrication processes use process chamber kits **22** comprising essentially the same chamber components **24a-f**. However, once such a process chamber kit **22** has been used in a first type of process chamber performing a first process application, it can no longer be used in a second type of process chamber serving another process application because it may contaminant the second process chamber. This situation commonly arises when a kit **22** of chamber components **24a-f** that have been used in one process chamber, such as a chamber for aluminum deposition or etching, are sent to the fabricator for cleaning or refurbishment. After the chamber components **24a-f** have been cleaned or refurbished, they are sent back to the customer. At that time, the package **20** for the chamber components **24a-f** is color coded to indicate the prior aluminum application, so that the chamber components **24a-f** are not accidentally used in a copper deposition or etching chamber or process.

The package **20** can also have stacking tabs **170** and corresponding recesses **174** that fit one another so that more than one package **20** can be stacked up in a column in a clean room. For example, the top surface of a first tray **50** of a first package **20** can have four tabs **170** that are located at the four corners of the surface, and the corresponding recesses **174** at bottom surface of the second tray **60**, as shown in Figure 5. When the first package **20** is stacked over a second package **22**, the four tabs **170** of the second package **21** fit into the corresponding recesses **174** in the bottom surface of the first package **20**. This tab and recess fitting allows the stacked packages **20, 21** to fit into one another so that they are not unstable when stored in the clean room.

Accordingly, the present invention provides a transportation package **20** that allows transportation of process chamber components **24a-f**, such as a kit of components **22**, from the fabricator or distribution center right into the customer clean room. The package **20** is reusable because the rigid impermeable tray surface can be easily cleaned. The trays **50,60** minimize contamination by having a smooth surface that is free of granular particles that can easily be abraded off. Also, each conformal

cell **92a-f** of the conformal package **20** can be used to retain a particular chamber component **24a-f** of a process chamber kit **22**, and is conformal to the shape of the chamber component **24a-f** to minimize breakage during transportation. In addition, the transparent portion of the cells **92a-f** allow visual examination of the contents of the package **20**, and inspection of each chamber component **24a-f** without breaking open seals and contaminating the articles.

Although the present invention has been described in considerable detail with regard to the preferred versions thereof, other versions are possible. For example, the cells **92a-f** can be merged together to form a continuous volume having different radial sections to allow transportation of a single chamber component having a complex external surface topography. In addition, the shape of the individual cells **92a-f** can be tailored for other purposes, for example, their external profile, which is not in contact with the component part can be shaped to mate with a correspondingly shaped recess in a shipping container. Therefore, the appended claims should not be limited to the description of the preferred versions contained herein.